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Soil quality — Determination of potential cation exchange capacity (CEC) and exchangeable cations buffered at pH 7, using a molar ammonium acetate solution

National foreword

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Foreword

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This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 3, *Chemical and physical characterization*.

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Introduction

Cation exchange capacity (CEC) is an intrinsic property of soil defining the concentration of negatively charged sites on soil colloids that can adsorb exchangeable cations. Cation exchange capacity can be a good indicator of soil productivity and is useful for making recommendations of phosphorus (P), potassium (K), and magnesium (Mg) if testing soils of different textures. Cation exchange capacity is also used for regulatory purposes in monitoring land application of biosolids.

Cation exchange capacity is a measure of exchangeable bases and soil acidity at some specific soil pH. The exchangeable bases and acidity neutralize negative charges arising from permanent charges due to isomorphic substitution in clays, or pH-dependent charges from hydroxyl groups on clay and oxides or carboxyl groups on soil organic matter. A common method for determining CEC uses 1 M ammonium acetate at pH 7 (neutral NH_4OAc) and is a standard method used for soil surveys by the Natural Resource Conservation Service.[6],[7] An advantage of CEC measured at a constant pH of 7 is elimination of CEC variability due to differences in soil pH. Thus, comparisons of CEC can occur across varied soil types and lime applications. A disadvantage of the neutral NH_4OAc method is that it may not provide a realistic depiction of the actual CEC at the natural pH of the soil, particularly with soils having considerable pH-dependent charge and a soil pH that is significantly different from 7. An unbuffered salt extract can be used to determine CEC at the natural pH of soil, for example, by using a hexamminecobalt(III)-chloride solution (see ISO 23470, References [6] and [7]).

The method described here determines potential cation exchange capacity (CEC) buffered at pH 7 and exchangeable cations Ca, Mg, K, and Na. Molar ammonium acetate is added to soil to saturate exchange sites with NH_4^+ and release exchangeable cations in a leachate which are measured. The exchanged NH_4^+ is then released either with 1 M KCl or 1 M NaCl and measured to quantify the potential cation exchange capacity at pH 7.

Ammonium acetate, due to its complexing effect, can contribute to the dissolution of part of soil carbonates and other salts present in the soil. Calcium concentrations (or even magnesium) are thus no longer limited to exchangeable quantities. Presence of other soluble salts such as gypsum, sodium chloride or else would also inflate exchangeable cation quantities.

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TECHNICAL SPECIFICATION **ISO/TS 22171:2023**

Soil quality — Determination of potential cation exchange capacity (CEC) and exchangeable cations buffered at pH 7, using a molar ammonium acetate solution

1 Scope

This document specifies a method for the determination of potential cation exchange capacity (CEC) and the content of exchangeable cations (Ca, K, Mg, Na) in soils using a molar ammonium acetate solution buffered at pH 7 as extractant.

This document is applicable to all types of air-dry soil samples which have been prepared, for example, according to ISO 11464.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Principle

Negatively charged sites on soil are saturated by ammonium ion, in leaching conditions, using a molar ammonium acetate solution. The leaching solution can be used to determine exchangeable cations by AAS or ICP AES measurements. An alcoholic solution is used to eliminate any remaining soluble ammonium ion. The soil test sample is then back extracted by a molar potassium chloride or sodium chloride solution, in order to liberate all ammonium cations fixed in the previous step. For practical reason, a single back extraction is performed. This is generally sufficient to assess the whole CEC as the molarity of the back-extraction solution is strong (molar solution of KCl), Ammonium cations are finally determined in the extract by a continuous flow spectrophotometric method.

5 Reagents

5.1 Water, with a specific conductivity not higher than 0,2 mS/m at 25 °C.

5.2 Ammonium acetatemolar solution at pH 7,00.

Two ways are available to prepare ammonium acetate solution: 5.2.1 or 5.2.2.

5.2.1 From acetate ammonium solid

Dissolve 77,0 g ± 0,1 g of ammonium acetate in a 1 000 ml flask, containing approximately 900 ml of water. Adjust the pH to 7,00 ± 0,05 using ammonia solution or acetic acid solution depending on pH initial. Make up to the volume with water and mix.

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